inextricably entangled in the medley of new systems made by Continental workers, all of which systems differ the one from the other as "chalk from cheese." It is a mere whim to imagine that chapters on "The Anatomy of a Snail" and "The Anatomy of a Fresh-water Mussel" should have been excluded since the basis of systematic zoology is anatomy. And it is a mere whim to cavil at the inclusion of the vars. *minor*, *maximi*, and "*albida*," (*exalbida*, if you please, Mr. Reviewer, for so was it named by Menke), and the monstrosity *sinistrorsum* of *Helix aspersa*, since Dr. Gwyn Jeffreys and Moquin-Tandon have named varieties and used variety-names, and since Prof. E. von Martens, than whom no better conchologist, expressly mentions that "it is certainly desirable that every local form, well-marked zoologically or geographically, should have a distinct name." And may I turn a reviewer on my own book, and ask myself how it is that I did not, as your reviewer desires, give the localities for every species, and make the book costly, and, by so doing, take it away from the reach of the poorer classes? Why also did I not give the definite localities for the now local species, when I considered rightly that some of them may turn up in other, and, perhaps, far distant spots to those now known? In conclusion, I would point out to your reviewer—for I must not occupy your valuable space to any greater extent—that as there is a virtue in the every-day affairs of this our mundane life which, to quote Seneca, is "the only immortal thing that belongs to mortality," so, as certainly, is there a virtue in right reviewing which is quite as exacting and quite as important to always bear in one's remembrance. J. W. WILLIAMS.

51 Park Village East, N.W.

IN reviewing Dr. Williams's little book, I wished not merely to point out the author's mistakes, but to guard young conchologists, to whom the book is addressed, from placing too great reliance on the statements it contains.

I felt also convinced that the author was not practically conversant with his subject; indeed, that his knowledge was purely derivative, and this the foregoing letter fully confirms.

I will not occupy space with a detailed criticism on the author's method of compilation, but will simply refer to a single instance, quoted to show his want of care in referring to the original sources of information, so needful in such a task. The method of numeration of the tooth-formula, referred to by me as incorrect at p. 7 of the "Hand-book," is now justified by the author, who quotes Woodward as his authority; but upon referring to my brother's "Manual" I find that my statement was fully justified by the fact that the quotation is *not correct*, it having been taken by Dr. Williams from Prof. Jeffrey Bell's "Comparative Anatomy," where my brother's name is given as the authority for the instances quoted, and not for the whole paragraph to which it is appended, and which does not appear in his book. To the second part of Dr. Williams's *whimsical* letter I feel sure it is needless to reply.

HENRY WOODWARD.

129 Beaufort Street, S.W., May 28.

Freaks of Nature.

I INCLOSE a letter from my grandson Charles, a boy, son of St. Vincent Erskine, the explorer, with whose travels you are probably acquainted.

This singular instance of a change in the habits of birds, consequent on the advance of civilization, is extremely important and interesting, as it evinces almost reasoning powers and adaptation of habits to circumstances. As you are aware, some birds in South Africa build their nests on the pendant boughs of willow-trees as a defence against snakes and iguanas.

These willows, like other trees in Natal, are rapidly becoming scarcer, as they are cut down, whilst the boys who take the nests increase. This is, no doubt, the cause of the birds changing their nests to the telegraph-wires, where they are also safer from their natural enemies.

It would be interesting to know whether similar instances occur elsewhere. D. ERSKINE.

47 Gratton Road, Kensington, May 25.

P.S.—It is remarkable also that the hole is at the side instead of the bottom, showing that the bird was aware that the situation was snake-proof. Darwin would have been glad of this proof of evolution.

WHILE watching the landscape of Natal between Ladysmith and Pietermaritzburg from a Natal Government Railway carriage, I saw some nests of the "golden weaver" bird. There were four of them hanging in a row, close together. They were the round kind, without the long arm. On one of the nests sat a cock weaver bird, but I saw no hens.

The nests seemed to be one or two years old, except one, which was greener than the others, and most certainly one of this season's. The chief peculiarity seemed to lie in the fact that the birds had woven grass round the wire for some six or eight inches, and two or three inches in circumference, before beginning to make the nest, and that the bird had to deal with a horizontal wire instead of a vertical stick or a branch. The bird always twists the grass round the branch (if he builds on a vertical twig) for some way up among the leaves and stalks, leaving the long ends free, thus forming his foundation. Weavers prefer to build on trees where the long slender twigs droop towards the ground, and so afford a nice vertical slender support. They are especially fond of the weeping-willow, whose slender switches generally branch off into two small shoots at the end: between these the bird loves to build his nest. Besides, the willow has lots of leaves very near together, and so holds the straws very well. On the wire he had no such support, but had to trust to his own ingenuity to overcome the novel situation, which task he seems to have accomplished very well.

The entrance to these nests was not at the bottom, as usual, but by a hole in the side, and all the nests did not look the same way.

I suppose there was only one nest a season or two ago, with a single pair of birds; soon we shall have a long string, or rather wire, of these ingeniously built homes with their happy quarrelsome occupants, making enough noise to stop all the messages ever sent that way. They will hear all the "Government" secrets: then we will be able to say truly, "A little bird told me." C. H. ERSKINE.

WHIRLWINDS, WATERSPOUTS, STORMS, AND ROTATING SPHERES.[1]

IT is often necessary, in many branches of science, to halt in our steady progress along the beaten roads of induction, and say, "*Fiat experimentum.*" We may not always be able by this means to reproduce exactly all the physical conditions of the phenomenon, we are investigating, or to evolve a test crucial enough to enable us to decide between rival hypotheses. Nevertheless, the power we thus gain, especially in the case of an atmospheric phenomenon, of seeing the entire system of action in a *coup d'œil*, of gauging its relative proportions, and of examining its dependence and effects on its *entourage*, can hardly be over-rated.

Such would appear to have been M. Weyher's object in the delicate and ingenious experiments which he has so skilfully elaborated and described in the pamphlet of 91 pages before us.

The physical theory of atmospheric eddies, including the rotating flat disk or cyclone, and the rotating column which manifests itself as a tornado, waterspout, or dust-whirl, according to variations in its intensity and surrounding circumstances, has lately been developed to an extent not generally known, principally by Ferrel, Sprung, Oberbeck, and Marchi. It is therefore decidedly satisfactory to those who believe in the progress of meteorology by rational theory and deduction, to find that the motions exhibited in M. Weyher's experiments, in which the conditions in Nature are very fairly imitated, agree in every point with those which have been deduced from their physical theory.

Theory, for example, shows that a tornado is due primarily to an unstable condition of saturated air, accompanied by a gyrating motion (which may initially be very small, and which is practically always present to some extent, owing to the earth's rotation), relative to some central point.[1]

---

[1] "Sur les Tourbillons, Trombes, Tempêtes, et Sphères Tournantes: Étude et Expériences." Par C. L. Weyher. (Paris, 1887.)

Given these conditions, the rest follow as necessary consequences, viz. (1) a current ascending up the *axis*, combined with rapid rotation round it; (2) a hyperboloidal funnel of rarefied air tapering downwards, and reaching the earth when the action is powerful, round the sides of which a condensed vapour-, or so-called water-spout, should usually prevail, owing to the sudden rarefaction of the air entering the central area through the sides or at the base, with the consequent lowering of the plane of condensation from the cloud-level which it usually occupies. When, therefore, it is said that "a waterspout is simply the cloud brought down to the earth by the rapid gyratory motion of the tornado,"[2] it is not meant that the cloud is actually carried downwards by an aërial current, since by theory the motion is precisely in the opposite direction; but that the *conditions* of *condensation* are propagated downwards from the cloud-stratum where they first commence. Neglect of this consideration, as well as the physical fact that condensation can only occur under most exceptional circumstances in a *downward* current, has led to many false deductions from apparent circumstances.

Theory, moreover, indicates that the current up the axis, together with gyration round it, which, by the conservation of rotational momentum, may become exceedingly rapid as the air approaches it, must combine to give a spiral character to the movement near the axis, while the conditions of continuity equally demand that there should be a compensatory descending current somewhere in the vicinity, gyrating spirally in the same sense, and of only moderate velocity, owing to its greater distance from the axis.

At the base of a tornado, or its milder form of water-spout, there should also be a rising up of the water at sea, or of light objects on land, which are supported by the ascending current until their collision or size carries them outside the central area, when they fall back to the earth, or to points where they are again brought within the influence of the whirl-currents. These and many other minor characteristics of tornadic action are confirmed and illustrated by M. Weyher's experiments.

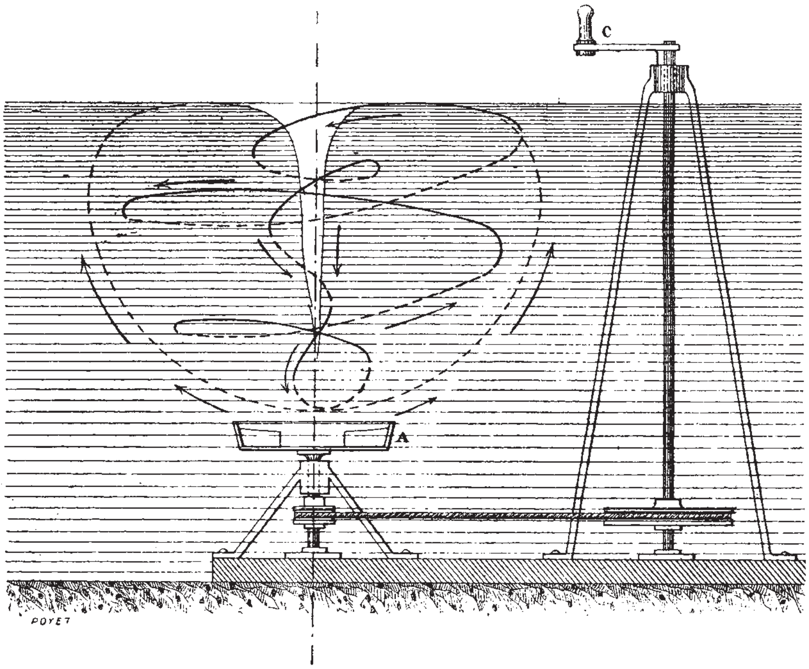

FIG. 1.

M. Weyher commences by examining the conditions which prevail in an eddy produced in water, either by an outflow through a sluice, or a momentary rotation imparted by the stroke of an oar. In the former case the motion is well known, but in the latter it is somewhat new to find that besides the rotation round a vertical axis there is an interchanging vertical motion such that each particle describes a descending helix down the axis of the whirl, and ascends in a helix of the same sense to regain the surface.

Fig. 1 shows the same circulation produced by the revolution of a tourniquet, A.

If this figure be looked at upside down, it substantially depicts what is believed to be the motion of the air in a whirlwind, waterspout, or tornado, and is precisely similar to what is found to be the motion round those artificially produced by M. Weyher.

The important point to notice with respect to these water eddies, which are introduced mainly to show their analogy to air-whirls, is that, according to M. Weyher, their source of action must be at some distance *below* the surface. By artificially causing the liquid to rotate at its surface only, he found it impossible to obtain the central descending funnel of a complete water eddy.

A similar condition is found to hold in an *inverse* sense in the case of artificially-produced air-whirls. The action must in their case originate in the *upper* part of the air-column, whence the motion is communicated by degrees to its lower boundary. The analogy, therefore, between the water eddy with a descending motion round its axis and the atmospheric whirlwind is completely *inverse*, and not *direct*, as some have supposed.

---

[1] Sergeant Finley found, in his review of 600 tornadoes in the United States, that the direction of rotation round the axis was invariably cyclonic, or against watch-hands ("Signal Service Notes," No. xii. p. 10).

[2] "Recent Advances in Meteorology" (p. 301), by W. Ferrel. (Washington, 1885.

M. Weyher next proceeds to discuss the motions which should theoretically occur in an air-whirl. These are shown in vertical section in Fig. 2.

In the annular region bordering the inner rarefied space, and represented by A*ac*C, *b*BD*d*, the air is assumed to be rendered denser than the normal by the centrifugal force of gyration, and according to M. Weyher it is by the *descent* of this denser air upon the depression caused by the air below rushing up to fill the central area, that the rotation system propagates itself from above towards the earth.

We do not think this explanation is either correct or necessary. It is contrary to the physical theory that there should be a sheath of dense air surrounding the rarefied region, and, apart from this, friction, and the transference of air up the axis from its lower end amply account for the downward propagation.

The most interesting of M. Weyher's experiments are those in which he artificially produces the phenomena of the waterspout. By means of a rotating tourniquet placed over cold water, an aërial eddy is caused which draws up the water, in the form of a spout composed of drops, to a considerable height; but when the water is heated, a clearly-defined condensed-vapour-, or, as it is popularly termed, water-spout, makes its appearance, like that shown in Fig. 3, which represents a form of the apparatus suitable for a chamber experiment.[1]

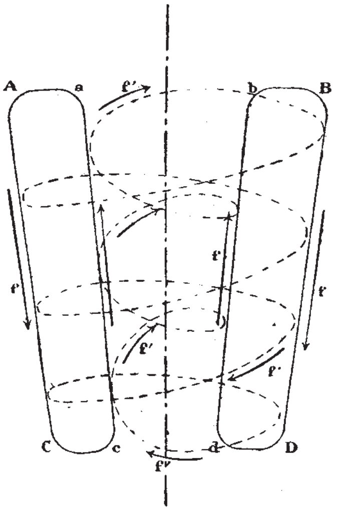

Fig. 2.

With from 1500 to 2000 rotations per minute, the vapour from the heated water is found to condense itself into a visible sheath enveloping a clearly-defined and rarefied central nucleus, conical, and tapering downwards. The diameter of the sheath is from ¾ inch to 1 inch. Besides this vapour-spout, water-drops are carried up, as in natural marine spouts, until they are thrown out beyond the influence of the upward current.

Other features of spouts are then imitated, particularly what is called the *hérisson*, which appears to be identical with what the French sailors call the *buisson*, or bush-like ploughing up of the sea, which occurs at their bases, both before and during the period of complete formation. This is effected by placing twenty or thirty small air-balloons in the place of the water, underneath the tourniquet. These are then seen to rise up a short distance, and fall back in graceful interlacing elliptical curves. The entire motion throughout the *hérisson*, as well as the whole system, is further studied by placing underneath the tourniquet a quantity of oatmeal in a glass vessel, and observing its motion by means of eye-pieces fitted into the top of the vessel. The motions are thus seen to be precisely the same as those theoretically inferred, and when the rotation is stopped, the ascending spires of the currents at the lower end, are found engraven in lines on the finer particles, which, in obedience to these currents, lie in a conical heap round the vertical axis of the whirl.

Several other experiments are made with cotton-wool and smoke, each of which exhibits some special feature characterizing the spouts of Nature.

The pressure and temperature conditions in different parts of the area are next investigated.

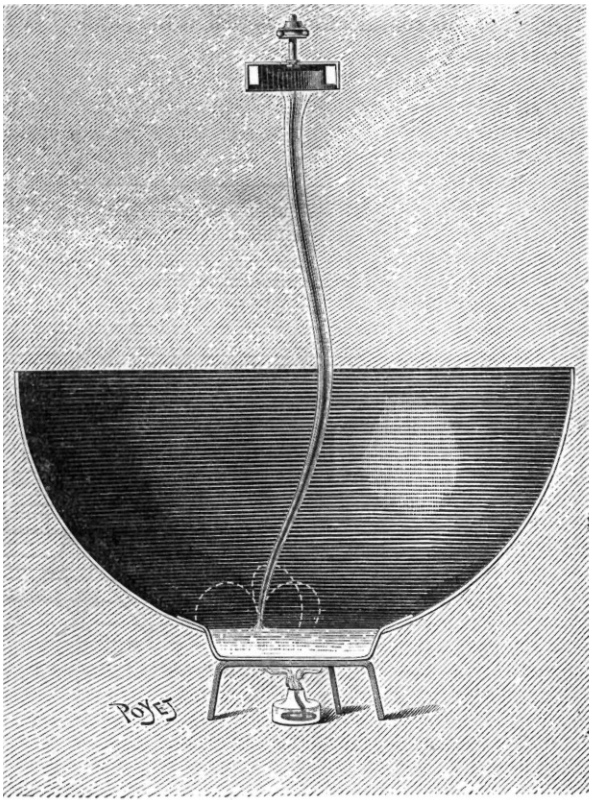

Fig. 3.

By means of a manometer, it is found that the rarefaction at the centre of the rotating tourniquet is transmitted almost unaltered in intensity (probably proportionally diminished in area) to the centre of the whirl on the surface, while the thermometer at the same point, at first shows a fall and then a rise of temperature, the latter evidently due to the friction of the rapidly moving air against the surface.

The analogous phenomenon of a cyclone is very fairly imitated by the apparatus shown in the accompanying diagram (Fig. 4), consisting of a large tourniquet placed over a table covered with a number of pins mounted with movable threads of red wool. The tourniquet is arranged so as to be capable of translation as well as rotation. At the centre, the table is pierced with a small hole at D, communicating by means of a caoutchouc tube with a manometer, which thus registers the changes of pressure as the supposed cyclone passes over it. On rotating the tourniquet and passing it along over the table, the directions and positions of the threads are seen to indicate not only the horizontal, but also the vertical components of the winds thus produced, including the region of calm in the centre, as well as the downward and outward motion at the anticyclonic border. The variations of pressure recorded by the manometer, when plotted out, show a curve similar to that in a symmetrical cyclone, including the rise of pressure at the border where the motion is descending and outwards.

---

[1] For those desiring to repeat the experiment the dimensions are as follows. The tourniquet is made of tin from 5 to 6 inches in diameter by 1 to 1½ inch in height. There are from 10 to 12 rectangular fans 1 inch by ¾ inch. The vessel holding the water is placed 31 to 39 inches from the tourniquet, and is from 7 inches to 1 foot in diameter by 1½ to 2 inches deep. The hemispherical continuation of the vessel, to keep off local air-currents, which disturb the continuity of the spout, is 3 feet in diameter.

Hail is then explained, as being caused by vapour drawn up into the *hérisson* of what M. Faye terms a *trombe internubaire*, which descends from the upper regions as far as the surface of the cloud, whence the hail proceeds. The rest of the explanation, which mainly involves a continual churning up and down of the frozen particles, is similar to that given by Ferrel and Möller, except that the hailstones impinging upon one another at the focus of the *hérisson* are supposed, by the heat thus engendered, to aid in effecting the temporary melting of their surfaces necessary to account for the concentric coats of snow and ice they usually exhibit.

M. Weyher's experiments do not, of course, fulfil all the conditions which prevail in Nature, since in that case the rotation is doubtless kept up, after it has once been started in the air at some distance above the surface, by the upward movement along the axis, and the consequent aspiration of the surrounding air into the area of gyration. With this exception, however, there seems little wanting.

The position of the source from which the vapour is drawn is not so important as might be thought, since the vapour condensed in the natural waterspout is not the cloud actually brought down to the surface, any more than it is—except for the space of a few feet at its lower extremity—the water bodily carried up, but is the result of the condensation, by rarefaction, of vapour previously contained invisibly, but certainly amply enough for the purpose, right down to the earth's surface. In fact, the origin of the vapour, being at the base, more nearly imitates Nature than if it were only supplied above in the form of a cloud.

M. Weyher's experiments so far, therefore, bear out the hypothesis that a system of rotating air-currents above the earth's surface, causes tornadic, waterspout, and dust-spout phenomena, by an aspiration *towards*, and a flow *up*, its axis, and show that such a system can propagate itself and its accompanying effects downwards without assuming any downward component along the axis.

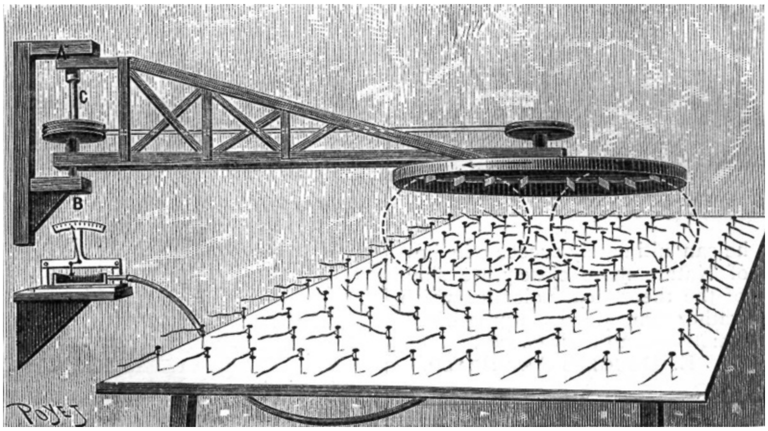

FIG. 4.

The last part of the work is devoted to a description of certain curious effects produced by rotating spherical tourniquets. Fig. 5 shows a convenient form of the apparatus, in which S represents a sphere made of eight or ten circular fans, fixed on an axis passing through two vertical disks whose function it is to keep off disturbing currents, and also to concentrate the action. M is an air-balloon, which, when the tourniquet is set in motion, is found to revolve round it in the plane of its equator, and be attracted instead of repelled.

M. Weyher thus explains this, at first sight, paradoxical motion. A rotating spherical ventilator draws in the air chiefly at its poles, and expels it in the plane of the equator, but, except *in this plane*, there is a general motion of the air all round *towards* the ventilator. The stream of air issuing from the ventilator in the plane of the equator is divided by the balloon, and forms vortices, which, together with the currents centrally directed on its reverse side, tend to urge it towards the ventilator. Whether this explanation be considered satisfactory or not, the balloon certainly revolves like a satellite round the ventilator. By means of floating gold-leaves, the action of the ventilator is seen to cause two dissymmetrical aërial whirls, whose inner gyrations commencing at some distance from the generating sphere, run round the polar axis in opposite directions, and meet on the plane of the equator. From thence the air jointly brought by these inner helices is driven outwards, and returns by similar helices, like the downward return-current of the tornado, to the points at the extremities of the prolonged polar axis. So far well, but we cannot quite admit the validity of the manometer experiment by which, on p. 74, the author attempts to show the existence of the aspiration in the plane of the equator requisite to explain the attraction it exerts on the air-balloon. The effect of velocity in decreasing pressure, as exemplified by Hawksbee's famous experiment, would probably mask any other vortical effects such as those sought by M. Weyher.

It appears to be a recognized custom for an author, after describing his experiments, to indulge in some pet speculations, and even to make the orthodoxy of the former an excuse for the frequently Utopian character of the latter.

M. Weyher certainly treats himself to an ample dessert of this description in his concluding section, in which, assuming the existence of a *ponderable* ether, the phenomena of the *tourbillon* are by analogy transferred to the solar system, which is supposed to be the *hérisson* of a whirl system reaching it from space, the sun being in the focus, and in which the planets, by the mutual influence of the ethereal whirls due to their axial rotation, cause simultaneously spots on the sun and cyclones on the earth.

We fail to follow M. Weyher here, and think it would have been better if he had not only hesitated, as he admits he did, but decided not to publish such wild speculations. His experiments are exceedingly instructive and suggestive, and if he can ultimately succeed in imitating the conditions of Nature more closely, we shall doubtless have an end of the theoretical polemics which have hitherto retarded rather than aided the progress of our knowledge of aërial motions and their causes.

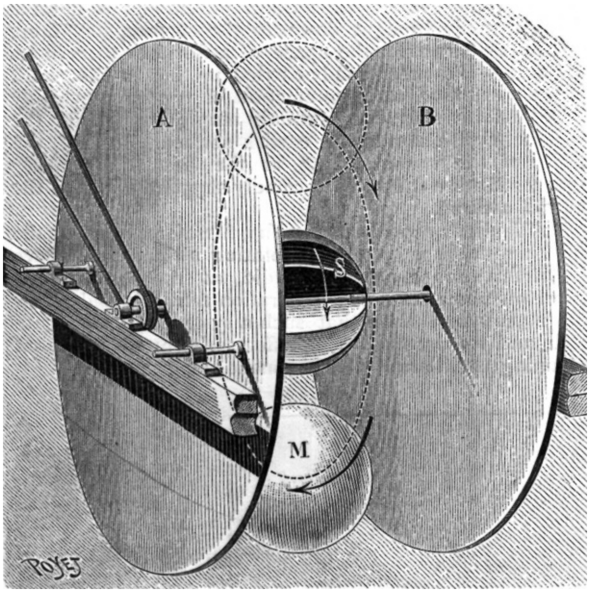

FIG. 5.

E. DOUGLAS ARCHIBALD.

TIMBER, AND SOME OF ITS DISEASES.[1]

VII.

IF we pass through a forest of oaks, beeches, pines, and other trees, it requires but a glance to see that various natural processes are at work to reduce the number of branches as the trees become older. Every tree bears more buds than develop into twigs and branches, for not only do some of the buds at a very early date divert the food-supplies from others, and thus starve them off, but they are also exposed to the attacks of insects, squirrels, &c., and to dangers arising from inclement weather, and from being struck by falling trees and branches, &c., and many are thus destroyed. Such causes alone will account in part for the irregularity of a tree, especially of a Conifer, in which the buds may be developed so regularly that if all came to maturity the tree would be symmetrical. But that this is not the whole of the case, can be easily seen, and is of course well known to every gardener and forester.

If we remove a small branch of several years' growth from an oak, for instance, it will be noticed that on the twigs last formed there is a bud at the axil of every leaf; but on examining the parts developed two or three years previously it is easy to convince ourselves of the existence of certain small scars, above the nearly obliterated leaf-scars, and to see that if a small twig projected from each of these scars the symmetry of the branching might be completed. Now it is certain that buds or twigs were formed at these places, and we know from careful observations that they have been naturally thrown off by a process analogous to the shedding of the leaves; in other words, the oak sheds some of its young branches naturally every year. And many other trees do the same; for instance, the black poplar, the Scotch pine, *Dammara*, &c.; in some ees, indeed, and notably in the so-called swamp cypress *Taxodium distichum*) of North America, the habit is so ronounced that it sheds most of its young branches very year.

But apart from these less obvious causes for the supression of branches, we notice in the forest that the ajority of the trees have lost their lower branches at a uch later date, and that in many cases the remains of e proximal parts of the dead branches are sticking out om the trunk like unsightly wooden horns. Some of these ranches may have been broken off by the fall of neighbourg trees or large limbs; others may have been broken by e weight of snow accumulating during the winter; others, gain, may have been broken by hand, or by heavy wind; nd yet others have died off, in the first place because the ver-bearing shade of the surrounding trees cut off the ccess of light to their leaves, and secondly because the ow of nutritive materials to them ceased, being diverted into more profitable channels by the flourishing, growing parts of the crown of leaves exposed to sunlight and air above.

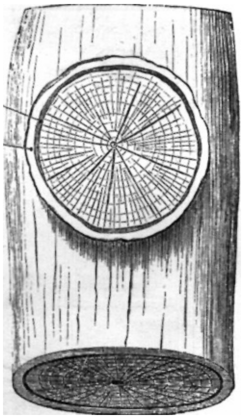

FIG. 21.—Portion of a tree from which a branch has been cut off close to the stem. *C*, the cambium of the branch; *B*, the cortex.

The point I wish to insist upon here is that in these cases of branch-breaking, however brought about, open wounds are left exposed to all the vicissitudes of the forest atmosphere; if we compare the remnant of such a broken branch and the scar left after the natural shedding of a branch or leaf, the latter will be found covered with an impervious layer of cork, a tissue which keeps out damp, fungus-spores, &c., effectually.

It is, in fact—as a matter of observation and experiment—these open wounds which expose the standing timber to so many dangers from the attacks of parasitic fungi; and it will be instructive to look a little more closely into the matter as bearing on the question of the removal of large branches from trees.

If a fairly large branch of a tree, such as the oak, is cut off close to the trunk, a surface of wood is exposed, surrounded by a thin ring of cambium and bark (as in Figs. 21 and 22). We have already seen what the functions of the cambium are, and it will be observed that the cut edge of the cambium (*C*) is suddenly placed under different conditions from the usual ones; the chief change, and the only one we need notice at present, is that the cambium in the neighbourhood of the cut surface is released

---

[1] Continued from vol. xxxvii. p. 516.